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Applicant: Pekka Koivukunnas et al.

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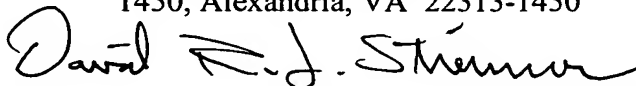
PCT App. No.: PCT/FI2003/000551

For: Arrangement for Guiding a Web and for Doctoring a Calender Roll in a Calender

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Submission of Substitute Specification Under 37 C.F.R. § 1.125

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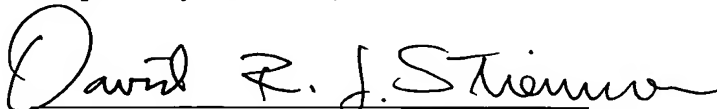
Dear Sir:

A substitute specification, excluding the claims, is filed herewith under the provisions of 37 C.F.R. § 1.125(b).

1. The substitute specification contains no new matter.
2. A marked-up copy of the substitute specification showing the matter being added to and the matter being deleted from the specification of record accompanies this paper. The matter being added is underlined and bold, and the matter being deleted is shown struck out, enclosed in brackets and bold.
3. The substitute specification is submitted in clean form without markings as to amended material.

Applicant requests that the accompanying substitute specification be entered in the application record.

Respectfully submitted,



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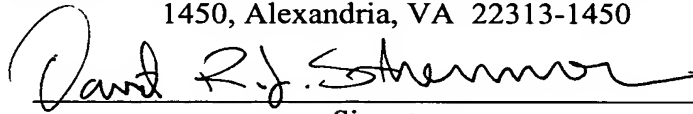
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Clean Copy of Substitute Specification under 37 C.F.R. 1.125(c)

TITLE OF THE INVENTION

Arrangement for Guiding a Web and for Doctoring a Calender Roll in a Calender

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] This application is a U.S. national stage application of International App. No. PCT/FI2003/000551, filed Jul. 8, 2003, the disclosure of which is incorporated by reference herein, and claims priority on Finnish Application No. 20021349, Filed
5 Jul. 9, 2002.

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER
FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

[0002] Not applicable.

BACKGROUND OF THE INVENTION

[0003] The invention relates to paper and equivalent fibrous web machines and, more specifically, the present invention relates to an arrangement in a calender for guiding a web, advantageously a paper web or an equivalent fibrous web, in the calender from one nip to another nip and for doctoring a calender roll.

[0004] Today, the general aim is to achieve higher running speeds for the web. As a result of this, the risks of roll vibration increase in fibrous web machines. Another problem caused by higher web speeds and partly by roll vibration is the separation of the web from the roll surface, which is accentuated at the dry end of the fibrous web machine when the web dries. Thus, in multi-roll calenders in which the web is guided from one nip between a pair of calender rolls to another nip between a pair of calender rolls a guide roll which does not have its own rotation drive, it becomes a problem, when the web separates from the surface of the guide roll, that the rotary movement of the guide roll, which is maintained by the movement of the web in contact with the guide roll, slows down and may even stop. When the web comes again into contact with the surface of the guide roll because of the tension caused by the draw of the web, a moment rotating the guide roll is generated but, because of the slowness of the guide roll, a speed difference is produced between the running speed of the web and the circumferential speed of the guide roll, and friction that decelerates the movement of the web is caused. In that connection, there is a considerable risk of a web break.

[0005] Traditionally, the calender roll is kept clean by means of a doctor, which comprises a doctor blade support means, by means of which a doctor blade is attached to a doctor beam which extends in the axial direction of the calender blade, i.e. in the cross direction, and which is in turn attached by means of support arms to a calender frame or to a bearing pedestal of a calender roll. Because of this kind of structural arrangement and in particular since other devices are also associated with the calender, such as web guide or reversing rolls and their support structures, the tending platform of the calender must be placed at a considerable distance, even too

far from the calender. If the doctor is again placed on the other side of the calender with respect to the tending platform, maintenance and visual control of the doctor will become a problem.

SUMMARY OF THE INVENTION

[0006] One object of the invention is to eliminate or at least substantially reduce the above-mentioned problems and drawbacks associated with multi-roll calenders of conventional fibrous web machines. In particular, it is an object of the invention to provide a novel, more compact structural arrangement for the calender for doctoring a calender roll and for guiding the web between nips between calender rolls. In addition, it is an object of the invention to prevent the web and its guide means from being only intermittently in contact with each other, which intermittent contact causes varying friction and increases the risk of a web break. It is also an object of the invention to reduce the space needed by the web guide means and the doctor and to assure easier serviceability of them. Further, an object of the invention is to create a guide means and doctor arrangement that is substantially less expensive than the conventional guide means and doctor arrangements, thus bringing about cost savings.

[0007] These objects are achieved by means of the arrangement mentioned at the beginning, the new and inventive basic idea of which arrangement is generally characterized in that the doctor is supported by a web guide means to which the support means of the doctor and the doctor blade have been attached and which includes at least one stationary, outwards curved, i.e. convex, guide surface which is not in contact with the web and which receives the web from one nip of the calender and over and on which the web is guided towards another nip of the calender, so that between the guide surface and the web there is a medium layer carrying the web, which layer is advantageously an air film.

[0008] In that connection, it is particularly advantageous in accordance with the invention that the guide means includes a first part, which serves as a convex web guide surface which receives the web from one nip and guides the web in its running direction to a subsequent nip, that the support means of the doctor blade are connected with a second part of the guide means, which second part is in the guide means on the side opposite to that of the first part, and that the air film covers

substantially the entire area of the first part between the guide surface and the web.

[0009] The guide means is formed of an at least partly convex guide plate, the outer surface of which forms a guide surface having a radius of curvature which is selectably variable or invariable. To stiffen the guide plate, it is recommended that a support or stiffening element be arranged between the edges or edge zones of the guide plate, which edges or edge zones extend in the axial direction of the calender roll, i.e. in the cross direction. In that case, the support means of the doctor are most appropriately attached to the support or stiffening element on the side of the calender roll, so that the doctor blade is directed towards the calender roll while supported by the support means.

[0010] The guide means forms a convex guide surface, which is advantageously a cylindrical surface, which is particularly advantageously a cylindrical surface of a non-rotating web guide or take-out roll, which cylindrical surface faces away from the calender roll. In that connection, the support means of the doctor have been attached to said guide or take-out roll, from which the doctor projects towards the calender roll. More generally, it may be noted that, in accordance with the invention, the non-rotating cylindrical guide means can be a straight tubular roll, a sectional roll, a bowed one-part take-out or spreader roll, a bowed multiple-part take-out or spreader roll. In accordance with the invention, the guide means having a convex web guide surface may also be a doctor beam of the doctor to which the support arm of the doctor blade is attached for supporting the doctor towards the calender roll.

[0011] When the web runs on the guide surface, there is an air and/or gas film between the web and the guide surface. The movement of the web from the nip towards the guide means can alone cause between the web and the guide surface an air and/or gas flow producing a film.

[0012] To enhance the flow of air to the space between the web and the guide surface, the arrangement in accordance with the invention is provided with at least

one cross-direction air and/or gas guide member, which, when attached to the arrangement, is located before the web guide means in the running direction of the web and guides the air and/or gas flow to the space between the web and the guide surface.

5 [0013] When the running or circumferential speed of the web is low and the web is porous, a condition may arise in which the movement of the web does not alone produce such an air and/or gas film between the guide surface and the web that carries the web to a sufficient extent. In that case, in addition to the flow coming with the web, it is possible to conduct air and/or gas between the web and the guide
10 surface through air and/or gas flow openings extending through the convex first part of the guide means and bounded within an edge in the shape of a closed periphery, the outer surface of which convex first part forms the guide surface of the web, or through flow passages extending as open to the guide surface, advantageously in a direction transverse to the running direction of the web, i.e. in the cross-direction.

15 [0014] An excessive air and/or gas flow to the space between the web and the guide surface can cause stagnation of air and thus formation of a decelerated air and/or gas layer. To prevent this, part of the air and/or gas film, advantageously the boundary layer of the film near the guide surface, can be passed to the inside of the guide means through the air and/or gas flow openings or passages extending through
20 the convex first part of the guide means, the outer surface of said part forming the guide surface of the web. It must be emphasized further that when the aim is to maintain an uniform pressure distribution over the entire area of the guide surface, air and/or gas flow(s) in part of the guide surface through the openings or passages to the inside of the guide means and in part of the guide surface through the
25 openings or passages to the space between the guide surface and the web.

[0015] Regarding the advantages of the invention, it may be mentioned that
- rotating guide rolls can be replaced with guide rolls, guide beams or the like which are non-moving with respect to the web, i.e. non-rotating, whereby the

- quantity of rotating masses is reduced,
- the web is guided between the nips on a carrying medium layer, such as a film, over guide rolls, guide beams or the like,
 - support of the web on the guide rolls, guide beams or the like can be enhanced by additional air and/or gas fed through the shell of a hollow guide roll, a wall of a hollow guide beam or the like,
 - the shape of the guide rolls, guide beams or the like can be optimized to provide an even pressure distribution between the guide surface of the guide roll, guide beam or the like and the web,
 - the doctor can be attached to the guide roll, guide beam or the like to the side of the calender roll that is doctored, thereby providing an integrated structure which is economical as to its costs,
 - in the integrated structure the doctor beam can be shaped into a guide means for guiding the web between nips,
 - the integrated structure can be disposed in a small space, so that, for example, the tending platform of the calender can be brought closer to the calender and the calender can always be placed at a location that is easier from the point of view of servicing and control,
 - in addition, devices for monitoring the temperature of the rolls and/or the moisture content of the fibrous web can be integrated with the guide roll, guide beam or the like without any problems.

[0016] In the following, the invention will be described by way of example through some of its embodiments and applications, yet not being limited to them, with reference to the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figure 1 is a schematic view of a first embodiment of the invention.

[0018] Figure 1A is an enlarged fragmentary view of the invention of Figure 1 taken at the region 1A.

5 [0019] Figure 2 is a schematic view of a second embodiment of the invention.

[0020] Figure 2A is an enlarged fragmentary view of the invention of Figure 2 taken at the region 2 A.

[0021] Figure 3 is a schematic view of an embodiment of the guide means.

[0022] Figure 4 is a schematic view of a second embodiment of the guide means.

10 [0023] Figure 5 is a schematic view of a third embodiment of the guide means.

[0024] Figure 6 is a schematic view of a fourth embodiment of the guide means.

[0025] Figure 7 is a schematic view of an embodiment of the invention for guiding air to the space between the web and a guide surface or vice versa in the web guide means.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] Figs. 1–7 illustrate schematically the arrangement in accordance with the present invention, which arrangement has been arranged in connection with a pair of rolls 1, 2 of a calender for doctoring one calender roll 2 of the pair of rolls and for guiding a web W, which is advantageously a paper web or an equivalent fibrous web, over and on a guide means 5 of the arrangement the pair of rolls 1, 2, which guide means 5 comprises at least one outwards curved, i.e. convex, guide surface 51 for the web W. Thus, the guide surface 51 receives the web W from one nip N and guides the web forward, most appropriately in the running direction of the web to the next nip of the calender (not shown in the figures). When the web runs on the guide surface 51, between the web and the guide surface there is a medium layer which carries the web and which is advantageously an air and/or gas film. Most appropriately, the film extends over the entire area of the guide surface between the guide surface 51 and the web W. In the following, such a medium layer is referred to by the definition “air film”.

[0027] It must be emphasized that the calender type per se is not essential from the point of view of the invention, but it is advantageous that the roll stack of the calender comprises at least three calender rolls which form at least two successive nips N, so that the arrangement in accordance with the invention can be arranged between two nips. It is particularly advantageous that the arrangement is positioned so that it is at least partly aligned with the calender roll 2 which is doctoring.

[0028] In general, the guide means 5 of the arrangement in accordance with the invention includes a first part 51, which comprises at least one stationary, outwards curved, i.e. convex, guide surface 51 which is not in contact with the web W and which receives the web from one nip N of the calender and over and on which the web is guided towards another nip of the calender. In addition, the guide means 5 includes a second part 52 which supports a doctor 4 and to which have been attached support means, or a support arm, 42, 43, 44 of a doctor blade 41 such that the doctor blade 41 is directed towards the calender roll 2 while the doctor blade is supported

by the support means 42, 43, 44. These first part 51 and second part 52 of the guide means are typically on the opposite sides of the guide means 5.

[0029] According to the embodiment shown in Fig. 1, the first part 51 of the guide means 5 is formed of a convex guide plate or guide the outer surface of which forms a convex and non-rotating guide surface 51 directed away from the calender. The shape of the guide surface 51 can be selected freely, so the radius of curvature may be selectably variable or invariable. It is recommended that the radius of curvature of the convexity of the guide surface shall be variable to provide a uniform pressure distribution between the guide surface and the web. It is also recommended that the curved guide plate is stiffened by means of a support or stiffening element extending in the axial direction of the calender roll 2 which is doctored, i.e. in the cross direction, which element is advantageously a plate, which is attached between the cross-direction free edges or edge zones 53 of the curved guide plate to form the second part 52 that makes the guide means stronger. In such a guide means 5 provided with a support or stiffening element it is advantageous to attach the support means 42, 43, 44 of the doctor blade 41 to the support or stiffening element of the guide means 5 on the side of the calender roll 2 which is doctored, so that the doctor is directed, while supported by the support means, towards the calender roll 2 to be doctored.

[0030] In connection with the embodiment shown in Fig. 1 it may be noted that the first part 51 and the second part 52 of the guide means can form together a doctor beam for the doctor 4. In that case, the web W runs over the doctor beam on an air film from a nip N to a subsequent nip and the doctor 4 has been attached to the wall portion of the doctor beam facing towards the calender. It must be emphasized that the cross-sectional profile of the almost semicircular hollow beam shown in Fig. 1 may be a full circle as shown in Figs. 2 and 6 or a quadrangular parallelepiped as shown in Fig. 7. In addition, it is recommended that the radius of curvature of the convexity of the guide surface 51 formed of the first part shall be variable to provide a uniform pressure distribution between the guide surface and the web.

[0031] In accordance with the embodiment shown in Fig. 2, a guide means 5 is formed of a cylindrical piece, so that a first part 51 forms, in accordance with the basic idea of the invention, an outwards curved, i.e. convex, and non-rotating guide surface 51, which is a cylindrical surface facing away from the calender. In accordance with one embodiment, the non-rotating cylindrical surface is the cylindrical surface of a guide or take-out roll of the web W, which cylindrical surface faces away from the calender roll. In such a guide means formed of a cylindrical piece, the half of the cylindrical piece facing towards the calender forms a second part 52 of the guide means 5, support means 42, 43, 44 of a doctor blade 41 being attached to the second part 52 such that a doctor 4 projects from the guide or take-out roll of the web W formed of a cylindrical piece towards a calender roll 2 which is doctored.

[0032] In accordance with the basic idea of the invention, an air or gas flow that produces an air film between the web W and the guide surface 51 can be brought about by the movement of the web alone from the nip N towards the guide means 5.

[0033] When the running or circumferential speed of the web W is low and/or the web is porous, a condition may arise in which the movement of the web does not alone produce such an air film between the guide surface 51 and the web W that carries the web to a sufficient extent. In that case, in addition to the air and/or gas flow coming with the web, it is possible to conduct air, which is illustrated with curved arrows in Figs. 3–5, to the space between the web W and the guide surface 51

- through air flow openings 6 which are bounded, as shown in Figs. 3 and 5, as open to the guide surface 51, within an edge in the shape of a closed periphery, or
- through flow passages 6 which extend, as shown in Fig. 4, as open to the guide surface 51, advantageously in a direction transverse to the running direction of the web, i.e. in the cross-direction, across the guide surface 51, so that the edges defining the air flow passage 6 are most appropriately

parallel to and spaced from each other,
which air flow openings and passages extend through the convex first part of the
guide means 5, the outer surface of which convex first part forms the guide surface
51 of the web.

5 [0034] Regarding the guide surface 51 provided with openings or passages 6, it is
noted further that in order to maintain a uniform pressure distribution between the
web W and the guide surface 51, the flow of air or gas through the openings or
passages can also take place such that the flow is directed in part of the guide surface
from between the web W and the guide surface 51 to the inside of the guide means 5
10 and in part of the guide surface from inside the guide means 5 to the space between
the web W and the guide surface 51.

[0035] As illustrated in Figs. 1, 2, 6 and 7, the flow of air to the space between the
guide surface 51 and the web W can be assured and enhanced by providing the
arrangement with at least one cross-direction air guide member 54. Such an air guide
15 member 54 is attached to the arrangement, to achieve the desired effect, in the
running direction of the web W before the guide means of the web such that it
guides the air and/or gas coming with the movement of the web W to the space
between the web and the guide surface 51. In the embodiments shown in Figs. 1 and
2, the air and/or gas guide member is on the same side of the guide means 5 as the
20 doctor 4 and it is situated between the doctor 4 and the web W, so that it forms a
wing-like air guide member.

[0036] Reference is made to Fig. 6 and it is noted that in connection with Figs. 1–5
above the invention has been described by means of embodiments and applications
in which the first part of the guide means comprises only one convex guide surface
25 51. When the height of the guide means 5 and, thus, the height of the guide surface
is not greater than the diameter of the calender roll 2 which is doctored and which is
at least partly aligned with the guide means, the angular deviation of the change of
direction experienced by the web W on the guide surface 51 is $\leq 180^\circ$. It shall be

emphasized that the guide means 5 comprising one guide surface is, however, not a necessity from the point of view of the operation of the invention but, in accordance with the invention, the convex guide surface 51 may comprise two or even more outwards curved, i.e. convex, guide surface parts 511, 512 placed one after the other.

5 When the guide means 5 is substantially in the shape of a parallelepiped as shown in Fig. 7 and has two guide surface parts 511, 512 and when the height of the guide means 5 does not exceed the diameter of the calender roll 2 which is doctored and which is at least partly aligned with the guide means, the angular deviation of the change of direction experienced by the web W on both guide surfaces 51 is $\leq 90^\circ$.

10 [0037] Reference is made to Figs. 3–6, which show the guiding of air and/or gas in the guide means 5 to the space between the web W and the guide surface 51 and vice versa from between the web and the guide surface to the inside of the guide means 5. An air and/or gas excessive flow to the space between the web W and the guide surface 51 can cause stagnation of air and/or gas and, thus, formation of a

15 decelerated air film. To prevent this, part of the air film, advantageously the boundary layer near the guide surface 51 of the air film, can be passed to the inside of the guide means 5 through the air flow openings or passages 6 extending through the convex first part of the guide means 5, the outer surface of which first part forms the guide surface 51 of the web W. In the embodiment of Fig. 7, the guide means has

20 a central air cavity,

- in which a constant pressure can be kept to maintain a to-and-fro flow in the flow openings or passages 6,
- into which air and/or gas can be conducted to pass a flow through the flow openings or passages 6 to the space between the web W and the guide surface 51, or
- from which air can be sucked to produce an air flow through the air flow openings or passages 6 away from the space between the web W and the guide surface 51.

[0038] Above, the invention has been described only by way of example by means of some of its embodiments and applications considered to be advantageous. It shall be understood that the invention is not meant to be limited to these only, but variations and modifications are feasible within the scope of protection of the inventive idea defined in the appended set of claims.

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